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ABSTRACT

This study tested the benefits of matching field dependent (FD) learners to an algorithmic method and field independent (FI) learners to a discovery method relative to mathematics achievement. It also attempted to discover if FD learners reacted more positively to computer experience than did FI learners. A total of 126 college algebra students identified as FD or FI were assigned to the two method groups by stratified random procedures, using a mathematics reasoning test scores as a stratified variable. Students completed 20 software lessons, working 30 minutes a day for 24 days. Ninety-three subjects' posttest scores and responses to the student reaction questionnaire were analyzed by multiple regression. The results suggest that: (1) there was no interaction effect between cognitive style and treatment on mathematics achievement; (2) FI learners scored significantly higher than FD learners on student reactions to the computer treatments; and (3) FD learners spent more time approaching the task. Twenty-one references are listed. (YP)

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Cognitive Styles Computerized Treatments in Mathematics

Achievement and Reaction to Treatments

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Cognitive Styles, Computerized Treatments on Mathematics Achievement and Reaction to Treatments

Perspectives

Aptitude Treatment Interaction (ATI) studies focused on matching individual learning characteristics to instructional treatment remain an important issue in educational research (Cronbach & Snow, 1981; Good & Stipek, 1983) and is the major thrust of this study. The learning characteristic, the cognitive style dimension, field dependent-independent has wide application to educational practice, particularly as it relates to algorithmic and discovery treatments, respectively, and when the computer is used as an instructional vehicle for mathematics achievement. According to Witkin, Dyk, Faterson, Goodenough, and Karp (1962), Witkin, Moore, Goodenough, and Cox (1977), Witkin, Moore, and Oltman et al. (1977), and Goodenough (1976), field independent learners (FIs) in the perceptual domain are capable of perceiving items as discrete from the background or field, tending to restructure their environment in a differential fashion. FIs, highly autonomous, learn better when allowed to develop their own strategies in problem solving, nonsocial domains. In contrast, field dependent learners (FDs) in the perceptual domain are less able to separate elements from their surroundings, tend to accept the organization provided by the perceptual field and experience

their environment in a more global way. The preference to interact with teacher will lead to more structure, mediation plans, or strategy is provided for them in social, non-classroom domains, and calling for cognitive restructuring skills. While Dague and Bruno (1981) emphasized the discovery treatment as one in which the learner actively produces certain concepts in a relatively unstructured problem-solving approach, it capitalizes on the strengths of the FI learner, whereas Carroll's (1980) definition of algorithms as a sequence of processes for handling information by specifying step by step procedures in a highly structure approach will meet the needs of FD learners by compensating for their ability to initially organize information. Consequently, the match of FDs to a discovery treatment and FDs to an algorithmic treatment is an appropriate approach to take in ATI studies. In contrast, Cosky (1981) proposed the adaptation of instruction to varying cognitive styles by using the computer as an instructional vehicle. Interestingly, the computer used in this way may handle some of the methodological problems associated with the "control and quality" of ATI studies (see Cook & Shipman, 1980), e.g., quality of teaching and implementing conceptualized treatments. Additionally, student reaction to the computerized treatments may indicate whether FD students, characterized by considerable need for social recognition and approval might respond less positively to a computerized instructional setting in contrast to FD students who prefer to work more autonomously--a setting provided by the computerized instruction.

The work of Kotovsky and Simon (1973) served as a frame work in developing a 20-item criterion-referenced mathematics achievement test in number series, using an RCN mastery learning criterion and the assumptions and research provided by Kaplan (1978), Swinyard (1984), and Savacho (1983), testing the relationship between computerized instruction and student attitudes prompted the design of an instrument by which students could react to the computerized treatments.

Objectives

The first problem of this study was to test the hypothesized benefits of matching FD learners to the algorithmic method and FI learners to the discovery method relative to mathematics achievement. The second problem of this study was to determine if there were significant differences between FD and FI cognitive styles on reactions to the computerized treatments. Specifically, the intent was to discern if FI learners reacted more positively to the computer experience than did FD learners.

Methodology and Instrumentation

The subjects for this investigation are selected from only the 287 algebra students enrolled at Colegio Universitario Metropolitano, a four-year college in Puerto Rico. Students were administered the Group Embedded Figure Test (GEFT) consisting of 7 practice and 18 test items, answered in a single 20-minute session. Split-half reliability was reported as .82 for males and females, and a validity of .71 for males and .80 for females (Witkin, Moore, Goodenough, & Cox, 1977; Witkin, Moore, Oltman et

out, resulting in 51 and 42 students in algebra units and discovery treatments, respectively. In a review of findings from 32 independent evaluations of computer-based college teaching, Kulik, Kulik and Cohen (1980) found that the average computer based withdrawal rate was 22.8%. Therefore, the dropout rate in the present study is less than the rate found in the literature. In addition a χ^2-test was conducted to determine if the withdrawal rate affected the findings. A non-significant value (χ^2 = .333, $t_{(.05)}$ = 3.84, χ^2 < t) was found. Ninety-three subjects' pretest scores and responses to the ERI were analyzed by multiple regression analysis at the .05 level. Analyses of covariance using regression procedures for mathematics ability as the covariate was used to adjust the achievement scores for differences in mathematics ability.

Results and Discussion

Table 1 shows that no significant interactions were found between cognitive style and treatment on mathematics achievement. However, an examination of the data showed that students' achievement scores were clustered at the high end of the scale, corresponding to a substantially asymmetrical curve, skewed to the left. Subsequent review of the reliability of the number series completion test by use of Subkoviak's estimation procedure for reliability indicated a .71 value for the probability of consistent classification adequate for criterion referenced test (Berk & Hall, 1979). Some explanations for nonsignificant interaction suggest the powerful role of mastery learning

features used in this study including the ICM mastery learning criterion; computers permitting individual rate of learning; and theory based designed curriculum in software, controlling for quality of teaching. Block 1974 also recommends that mastery learning features produce outcomes that are very similar and at the higher levels of achievement. Post hoc regression analysis on response time with cognitive style, method, and interaction entered that cognitive style contributed to 21.7% of the variance and was significant beyond the .05 level (see Table 2). Specifically, there were significant differences (F = 23.11, df = 1,31, p<.05) between FDs and FIs response time. FDs spent significantly more time approaching the task, no doubt permitting them to achieve all within the 24-day treatment period. Table 3 shows significant findings regarding the cognitive style variable and results on the computer treatments. Cognitive style accounted for 18% of the variance. FIs scored significantly higher (M = 102.81, SD = 2.77) than FDs (M = 80.76, SD = 15.16), suggesting that the autonomy under computerized instruction provides support the cognitive style elements of FI learners.

Importance of the Study

While the cognitive style variable, matched with appropriate treatment and mastery learning, produced high achievement scores for all learners, mastery learning features may have contaminated the potential interactions of the match of cognitive style to treatment. Obviously further ATI research using cognitive style

treatment should take an effort to control for these features. The use of computers in ATI research is promising since well-designed soft ware can control for methodological problems and computerized instruction contributes to a student's sense of locus control over learning, pace of learning, and sense of autonomy-all important variables in studying individual differences in learning.

Table 1.

Summary Table (All Ventures on Participants)

Variable	Multiple R	R^2	Adj. R^2 change	F	Sig.
Cognitive style	.xxx	.xxx	.xxx	.xx	xx
Method	.xxx	.xxx	.xxx	.xx	xx
Interaction	.xxx	.xxx	.xxx	.xx	xx

Note. F (x, xx) = x.xx, p < .xx

Table 2.

Regression Analysis for the Full Model on Response Time

Variable	R^2	R^2 change	F	Sig.
Cognitive style	.xx	.xx	xx.xx	x
Method	.xx	.xxx	.xx	xx
Interaction	.xxx	.xx	.xx	xx

Note. F (x, xx) = x.xx,

p < .xx.

Table 3

Summary Table (All Ventures on Planning Teamwork)

Variable	Multiple R	R^2	Adj. R^2 change	F	Sig.
Cognitive style	.xxxx	.xxxx	.xxxx	xx.xxx	x
Method	.xxxx	.xxxx	.xxxx	.xxx	xx
Interaction	.xxxx	.xxxx	.xxxx	.xxx	xx

Note. F (x, xx) = x.xx, p < .xx

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